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BIOLOGICAL EVALUATION
WESTERN SPRUCE BUDWORM IMPACT EVALUATION
ON THE
BRIDGER-TETON NATIONAL FOREST
1976-1977

FOREST INSECT AND DISEASE MANAGEMENT
STATE AND PRIVATE FORESTRY
U. S. FOREST SERVICE
OGDEN, UTAH

BIOLOGICAL EVALUATION

Western Spruce Budworm Impact Evaluation on the
Bridger-Teton National Forest
1976-1977 1/

INTRODUCTION

One of the most persistent infestations of western spruce budworm, (Choristoneura occidentalis Free.) in Region 4 is located in western Wyoming on portions of the Bridger-Teton and Targhee National Forests. This outbreak was first reported on the Bridger-Teton Forest in 1965 when 10,000 acres of light defoliation were observed during aerial surveys. The infestation rapidly increased and by 1968 had spread to the Targhee and Caribou National Forests in Idaho. At that time the number of acres infested had increased to 132,000. The following year, populations and damage began to decline. By 1972 the defoliated area was reduced to 66,000 acres. Natural factors continued to suppress the infestation, and by 1973, there was no visible defoliation.

In 1974, aerial surveys again showed 20,000 acres of budworm defoliation on the Bridger-Teton and adjoining Targhee National Forests. The reason for this rise in noticeable foliage damage is believed to have been due to high temperatures and low precipitation during June. Such conditions are known to be favorable to rapid larval development and high survival. Climatic conditions continued to favor budworm growth and by the following summer this infestation exhibited more than a six-fold increase in defoliated area. In 1976, the outbreak covered 141,200 acres on the Bridger-Teton Forest and 12,960 acres on the southeastern portion of the Targhee Forest.

Forest managers, private landowners and the general public have been concerned over this sudden and intense increase of budworm defoliation. Heavy defoliation was visible on Snow King Mountain--picturesque setting for Jackson, Wyoming, and along the Grand Canyon of the Snake River, which provides a main route to Grand Teton and Yellowstone National Parks. Region 4 entomologists were asked to conduct an indepth impact survey similar to surveys carried out on the Boise, Payette, and northern portions of the Targhee National Forests. The purpose of the survey was to provide all concerned persons with data on current and expected defoliation, top-kill, and mortality to both overstory trees and regeneration.

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TECHNICAL INFORMATION

INSECT: Western spruce budworm, Choristoneura occidentalis Free.

HOST TREES Douglas-fir, Pseudotsuga menziesii (Mirb).

Subalpine fir, Abies lasiocarpa (Hook) Nutt.

Engelmann spruce, Picea engelmanni Parry.

TYPE OF DAMAGE: Defoliation, top-killing and mortality of host trees.

LOCATION: The Bridger-Teton National Forest from Jackson, Wyoming, south to the Greys River. The southeast portion of the Targhee National Forest from Hoback Junction to Alpine Junction.

EXTENT OF INFESTATION: Approximately 141,000 acres of forested land on the Bridger-Teton National Forest from Twin Creek Ranch south to Grizzly Basin on the Greys River, then northwest to Palisades Reservoir, then north to Elk Creek on the Targhee National Forest (encompassing nearly 13,000 acres of infested land on the Targhee Forest), then east to the Snake River (Figure 1).

SURVEY PROCEDURES

The results and conclusions of this evaluation are based upon four independent but closely related surveys. These include aerial, individual stand impact, larval sampling, and egg mass surveys.

The aerial survey of the area was flown and mapped by entomologists from the Ogden Zone on September 1-5, 1976. The budworm infested areas were classified into three defoliation categories: light, moderate, and heavy, depending upon the amount of visual damage.

From the aerial surveys, eight stands were selected in which to conduct impact studies. These stands represented each of the three defoliation categories and varied in size from 60 to 100 acres. Transects were marked through each stand at 10-chain intervals, and a plot center was established every 5 chains along each transect. Each plot center was used for both a variable and a fixed radius plot. A Relaskop at 40 BAF was used to determine "in" trees for the variable plots. "In" trees were recorded by species, dbh, height and damage rating. Fixed plots, established at the same center point, consisted of all trees less than 5" dbh within a 6.8 foot radium (1/300 acre). Fixed-plot trees were recorded by species and damage class. The species and damage class were the same for both variable and fixed plots. Only live trees (and those thought to have been killed by budworm) were recorded for the following species: Douglas-fir, subalpine fir, Engelmann spruce, and lodgepole pine. The damage classes were as follow:

0 = No defoliation
1 = Current year defoliation
2 = Current year plus defoliation of older needles
3 = Less than 10 percent top-kill
4 = 11 to 33 percent top-kill
5 = More than 33 percent top-kill
6 = Complete tree mortality due to spruce budworm

In addition to the variable and fixed-plot data, increment cores were obtained from each of the stands. These cores have not yet been analyzed to determine how much, if any, radial growth loss has occurred to host trees over the past 10 years of the infestation.

Impact survey data was collected during November 15-22. It involved a three-man crew consisting of one forestry technician and one forestry aid, both from the Gros Ventre Ranger District, and one biological technician from Forest Insect and Disease Management, Ogden, Utah. All data from this impact evaluation were compiled and analyzed by computer programs. Summaries for each stand can be found in the Appendix.

During the field seasons of 1975 and 1976, permanent plots were established from which budworm larvae and egg mass populations were sampled (Figure 1). A plot consisted of 3 codominant Douglas-fir located somewhere in or near the infested area. The trees were grouped close together, 50 to 100 feet apart, and were usually located at least 200 feet from any access road.

Larval surveys were conducted July 23-27, 1975, and July 7-14, 1976, by biological technicians from the Ogden Field Office. From each of three trees in a plot, two 18-inch branches were cut with a telescoping pole pruner from the opposite sides at mid-crown. The number of budworm larvae and pupae on each branch was counted and recorded. The summary for each plot can be found in Table 1.

Egg mass sampling was the fourth survey involved in this evaluation. These samples were also collected at each of the permanent budworm plots. Using a telescoping pole pruner, four 70-cm branches were cut at mid-crown on opposite sides from each of the plot's three trees. Of the four branches from each tree, two were used to determine current year defoliation. The two remaining branches were individually labeled, bagged, and shipped to the FIDM laboratory in Ogden where each branch was carefully examined for spruce budworm egg masses. These egg masses were tallied, recorded, and summarized for each plot. The standards for predicted defoliation from these egg mass data are shown below:

Number of Egg Masses Per Plot (70-cm branch)	Predicted Defoliation (Percent)	Damage Category
0-2	0-25	Light
3-6	26-40	Moderate
7-24	41-55	Heavy
25	56-100	Very Heavy

RESULTS AND DISCUSSION

Aerial surveys flown in 1976 indicated an increase in area as well as intensity of this budworm infestation over 1975 surveys. This increase verified the defoliation predictions in 1975 which, based on high egg mass counts, indicated very heavy defoliation in most of the sampled areas (Table 4). Larval samples obtained in July of 1975, compared to samples taken from the same plots in 1976, showed a static trend in the budworm populations (Table 1). This indicated that defoliation would be at least as much in 1976 as it was in 1975.

In order to determine the exact impact of this infestation, 8 plots were closely examined and analyzed. The results are summarized into several tables included in this report. Tables 2 and 3 are averages of the 8 stands sampled. Several facts are listed below from these averages:

1. Of the total volume, 89.5 percent was Douglas-fir, 3.9 percent subalpine fir, 3.5 percent Engelmann spruce, and 3.1 percent lodgepole pine.

2. Of the 204 trees per acre of Douglas-fir, only 3 percent was undamaged by spruce budworm, while 41.3 percent was defoliated to some degree, and 58.4 percent had suffered up to one-third top-kill. Thus far, no significant mortality has resulted from budworm activity.

3. Nearly all of the subalpine fir and Engelmann spruce within the infestation had heavy defoliation and a slight amount of top-kill. However, these species make up a very small portion of the stand.

4. Generally, the smaller trees suffered the most damage. This is due to a larger concentration of older larvae which drop from the overstory when disturbed by wind, rain, etc. Hence, these smaller trees with less foliage cannot withstand heavy defoliation and soon exhibit top-kill.

5. Analysis of regeneration showed nearly 23,000 trees per acre of which 53.5 percent was Douglas-fir, 45.1 percent subalpine fir, .4 percent Engelmann spruce, and 1.0 percent

lodgepole pine. While 56.9 percent of the nearly 23,000 host trees per acre was unaffected by budworm activity, 30.4 percent was defoliated to some degree, 10.7 percent of the Douglas-fir regeneration was killed. This data includes all trees less than 5 inches dbh, the majority of which was less than 6 inches tall.

Since an analysis of the increment core study has not yet been completed, the actual amount of radial growth loss to Douglas-fir is unknown. However, similar surveys on the Boise and Payette National Forests, both of which have comparable budworm infestations, showed a 20-30 percent reduction in radial growth due to budworm activity. It is reasonable to assume that such losses may also be occurring in the Bridger-Teton infestation which includes the southeastern portion of the Targhee Forest.

Barring unforeseen natural control factors, heavy to very heavy defoliation was expected in 1977. Growth reduction, top-killing, and mortality was also expected to continue and perhaps increase. This prediction was based on the results of 1975 and 1976 egg mass surveys (Table 4). These data indicated a static trend in the population with extremely high egg mass counts resulting in heavy to very heavy defoliation predictions for 1977.

Contrary to these predictions, the 1977 western spruce budworm defoliation damage was substantially less. Aerial surveys conducted August 12-15, 1977, indicate the infestation subsided in intensity as well as area from 1976. The total infested area dropped 88,600 acres (63 percent reduction) on the Bridger-Teton National Forest and 12,500 acres (96 percent reduction) on the southeastern portion of the Targhee National Forest.

Other surveys indicate a population decline. As shown in Table 5, samples taken from 22 established larval sample plots revealed larval populations were down 79 percent from 1976. Egg mass samples confirm this reduction in that 20 of the 26 egg mass plots showed a significant decrease in egg mass counts from 1976 (Table 6). However, most of these counts are sufficiently high to warrant predictions of heavy to very heavy defoliation in 1978.

Although it is not fully understood what caused the decline in the budworm population, it is quite probable that sudden freezing temperatures ($-8^{o}C$ to $-1^{o}C$) in the first ten days of September 1976 had an adverse affect on both eggs and newly hatched larvae. According to Johnson and Denton (1975), freezing temperatures in September 1965 on the Salmon National Forest, reduced egg hatching and presumably killed budworm larvae in the first and second instars.

RECOMMENDATIONS

The visual defoliation was considerably less in 1977 than it has been for several years. However, egg mass surveys indicate heavy to very heavy defoliation for 1978 in most of the areas sampled. Therefore, Forest Insect and Disease Management personnel, land managers, and private landowners should continue to pursue the following recommendations:

1. Forest Insect and Disease Management personnel, in cooperation with Forest Insect and Disease Research and the Methods Application Group should continue to explore promising pesticides to reduce the impact of the western spruce budworm.

2. In budworm-prone stands of the West, land managers should encourage the use of non-susceptible host trees, shorten rotation whenever possible, break up large areas of susceptible host type and direct management toward younger, more thrifty stands.

3. Insect and Disease Management personnel should conduct aerial detection, parasite, egg mass, and expanded stand impact surveys in 1978 to provide land managers with pertinent information on western spruce budworm.

Recommended by:

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REFERENCES

Johnson, P.C. and R.E. Denton. 1975. Outbreaks of the western spruce budworm in the American Northern Rocky Mountain area from 1922 through 1971. USDA Forest Service General Technical Report. INT-20. 144 pp.

APPENDIX

Figure 1. Generalized distribution of Spruce Budworm defoliation on the Bridger-Teton National Forest.

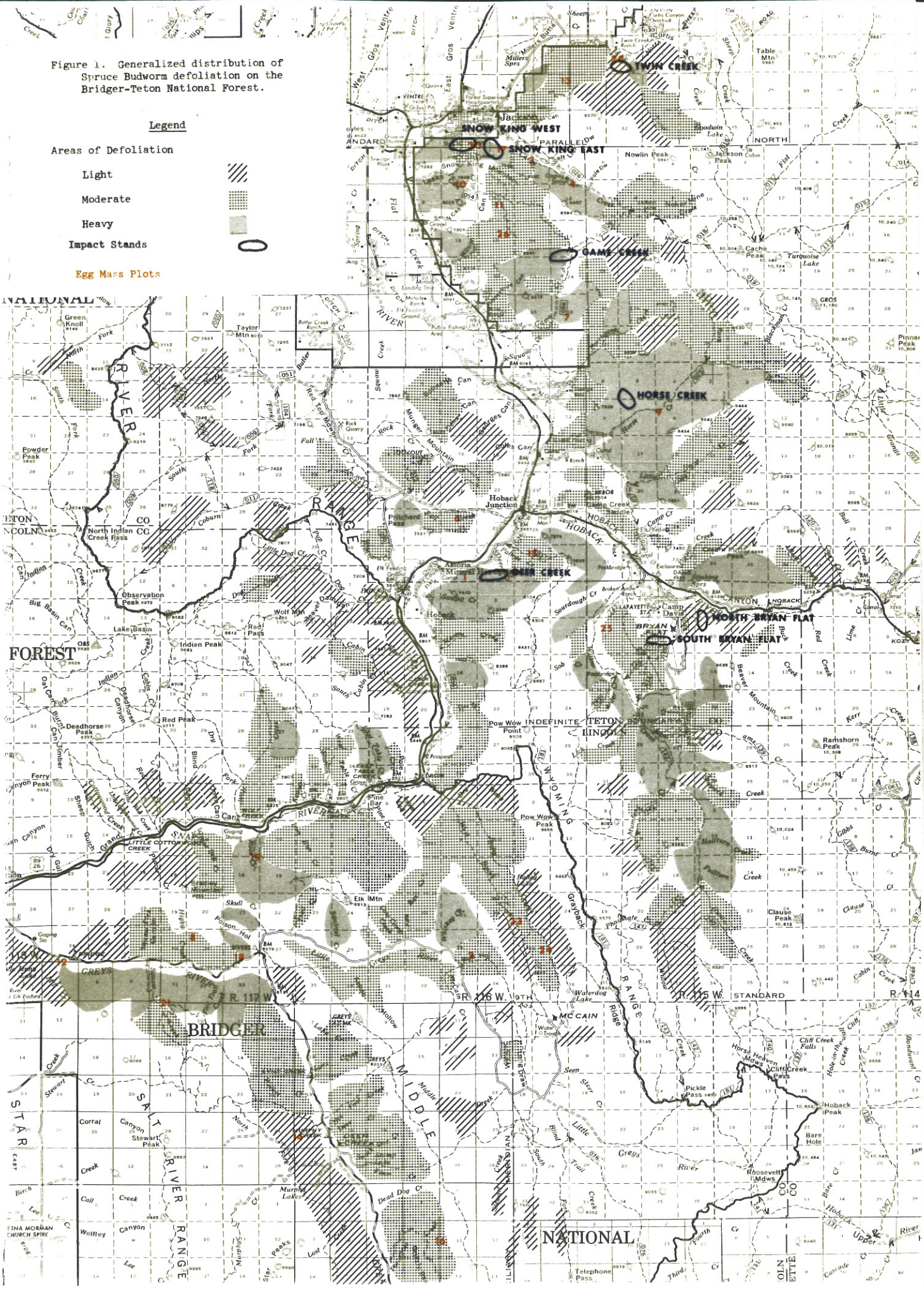

Table 1. Analysis of SBW Population Trend, Bridger-Teton National Forest

Plot Location	1975						1976						Trend	
	No. of Larvae		No. of Pupae		Total per plot		No. of Larvae		No. of Pupae		Total per Plot			
	SBW	Other	SBW	Other	SBW	Other	SBW	Other	SBW	Other	SBW	Other	SBW	Other
Astoria Hot Springs	4	8 1/	39	5	43	13	84	1	9	3	93	4	Increasing	Decreasing
Bull Hollow	35	14	35	16	70	30	50	6	8	4	58	10	Decreasing	Decreasing
Cache Creek (Lower)	47	6	52	4	99	10	88	1	1	0	89	1	Static	Static
Cache Creek (Upper)	55	7	55	0	110	7	132	6	1	2	133	8	Increasing	Static
Fall Creek	58	10	143	2	201	12	69	8	9	0	78	8	Decreasing	Static
Higby Creek	46	2	68	1	114	3	54	1	16	0	70	1	Decreasing	Static
Horse Creek	36	8	72	12	108	20	113	1	19	4	132	5	Increasing	Decreasing
Leek's Canyon (Lower)	1	0	24	12	25	12	48	9	4	3	52	12	Increasing	Static
Leek's Canyon (Upper)	51	16	69	19	120	35	134	25	5	2	139	27	Increasing	Static
Porcupine Creek	94	12	23	0	117	12	91	3	8	1	99	4	Decreasing	Static
Radio Point	3	9	54	8	57	17	75	10	10	9	85	19	Increasing	Static
Total					1064	171					1028	99	Static	Decreasing
Average Per Plot					96.7	15.5					93.5	9.0	Static	Decreasing

1/ Lepidoptera other than spruce budworm.

Table 2. Stand Structure Analysis (Trees and Volume Per Acre) of SBW Impact; Average of Eight Stands Sampled on the Bridger-Teton National Forest, 1976.

Average Damage Class	Species												Total All Spp.	
	Douglas-Fir			Subalpine Fir			Engelmann Spruce			Lodgepole Pine				
	Trees/ Ac.	% of Stand	Ave. DBH	Trees/ Ac.	% of Stand	Ave. DBH	Trees/ Ac.	% of Stand	Ave. DBH	Trees/ Ac.	% of Stand	Ave. DBH	Trees/ Ac.	% of Stand
0	.6	.2	9.0											
1	23.1	9.1	13.2	1.8	.7	5.0				24.5	9.6	9.3	25.1	9.8
2	61.2	24.0	13.5	.2	.1	16.0	1.2	.5	16.2				24.9	9.8
3	117.3	46.1	9.5	21.6	8.5	9.9	1.2	.5	9.5				62.6	24.6
4	1.8	.7	5.0										140.1	55.1
5													1.8	.7
6														
Total	204.0	80.1		23.6	9.3		2.4	1.0		24.5	9.6		254.5	100.0
	Vol./ Ac	% of Stand	Ave. DBH	Vol./ Ac.	% of Stand	Ave. DBH	Vol./ Ac.	% of Stand	Ave. DBH	Vol. / Ac.	% of Stand	Ave. DBH	Vol/ Ac.	% of Stand
0	2.9	.1	9.0											
1	986.5	22.7	13.2							136.4	3.1	9.3	139.3	3.2
2	2397.0	55.1	13.5	22.9	.5	16.0	149.0	3.4	16.2				986.5	22.7
3	504.5	11.6	9.5	146.6	3.4	9.9	5.5	.1	9.5				2568.9	59.0
4													656.6	15.1
5														
6														
Total	3890.9	89.5		169.5	3.9		154.5	3.5		136.4	3.1		4351.3	100.0

Average number of plots per stand - 18.1

Average acres per stand - 90.6

Table 3. Analysis of Regeneration - Average of Eight Stands Sampled on the Bridger-Teton National Forest, 1976.

Average Damage Class	Species - All Trees <5" DBH								Total All Spp.	
	Douglas-Fir		Subalpine Fir		Engelmann Spruce		Lodgepole Pine			
	Trees/ Ac.	% of Stand	Trees/ Ac.	% of Stand	Trees/ Ac.	% of Stand	Trees/ Ac.	% of Stand	Trees/ Ac.	% of Stand
0	5513	24.1	7463	32.6	38	.2	225	1.0	13239	57.9
1	1088	4.7	1500	6.5					2588	11.2
2	3338	14.6	1013	4.4	38	.2			4389	19.2
3	1425	6.2	300	1.3					1725	7.5
4	188	.8	75	.3					263	1.1
5	488	2.1							488	2.1
6	225	1.0							225	1.0
Total	12265	53.5	10351	45.1	76	.4	225	1.0	22917	100.0

Table 4. Prediction of Defoliation for 1976 and 1977, Bridger-Teton National Forest

Area	Plot Location	Predicted Defoliation for 1976			Predicted Defoliation for 1977			Class
		1975 2/			1976 3/			
		Egg Masses	Percent	Class	Egg Masses	Percent	Class	Trend
1 1/	Astoria Hot Springs	46	56-100	Very Heavy	28	56-100	Very Heavy	Static
2	Bull Hollow	210	56-100	Very Heavy	25	56-100	Very Heavy	Static
3	Cache Creek (Lower)	83	56-100	Very Heavy	38	56-100	Very Heavy	Static
4	Cache Creek (Upper)	201	56-100	Very Heavy	30	56-100	Very Heavy	Static
5	Deer Creek	NS 4/			27	56-100	Very Heavy	--
6	Fall Creek	110	56-100	Very Heavy	29	56-100	Very Heavy	Static
7	Game Creek	NS			62	56-100	Very Heavy	--
8	Higby Creek	101	56-100	Very Heavy	30	56-100	Very Heavy	Static
9	Horse Creek	43	56-100	Very Heavy	61	56-100	Very Heavy	Static
10	Leek's Canyon (Lower)	32	41-55	Heavy	23	4-55	Heavy	Static
11	Leek's Canyon (Upper)	298	56-100	Very Heavy	77	56-100	Very Heavy	Static
12	Mill Creek	NS			10	41-55	Heavy	--
13	Miller	NS			49	56-100	Very Heavy	--
14	North Fork Murphy Creek	NS			10	41-55	Heavy	--
15	Palmer Creek	NS			11	41-55	Heavy	--
16	Porcupine Creek	196	56-100	Very Heavy	58	56-100	Very Heavy	Static
17	Radio Point	152	56-100	Very Heavy	58	56-100	Very Heavy	Static
18	Roger's Gulch	NS			28	56-100	Very Heavy	--
19	Roos Creek	182	56-100	Very Heavy	59	56-100	Very Heavy	Static
20	Snow King	74	56-100	Very Heavy	78	56-100	Very Heavy	Static
21	Squaw Creek	56	56-100	Very Heavy	23	41-55	Heavy	Decreasing
22	Twin Creek Ranch	NS			27	56-100	Very Heavy	--
23	West Baily (Lower)	NS			43	56-100	Very Heavy	--
24	West Baily (Upper)	NS			53	56-100	Very Heavy	--
25	Willow Creek	NS			38	56-100	Very Heavy	--
26	Wilson Canyon	NS			83	56-100	Very Heavy	--
Total of plots sampled		1784			1058			
Ave. per plot sampled		127	56-100	Very Heavy	41	56-100	Very Heavy	Static
Ave. per tree		25.5			13.6			

1/ Number correspond to the egg mass plot locations on Figure 1.

2/ Five-tree sample plot

3/ Three-tree sample plot

4/ NS: No sample taken

Table 5. Spruce Budworm Larvae per Cluster 1976 - 1977, Bridger-Teton National Forest.

AREA	1976	1977	TREND
Astoria Hot Springs	93	0	Down
Bull Hollow	58	21	Down
Cabin Creek	50	12	Down
Lower Cache Creek	89	21	Down
Upper Cache Creek	133	50	Down
Deer Creek	167	2	Down
Fall Creek	78	12	Down
Game Creek	108	41	Down
Higby Creek	70	23	Down
Horse Creek	132	19	Down
Lower Leeks Canyon	52	29	Down
Upper Leeks Canyon	139	29	Down
Mill Creek	16	0	Down
Palmer Creek	29	4	Down
Porcupine Creek	99	30	Down
Radio Peak	85	27	Down
Roos Creek	105	9	Down
Snow King	52	5	Down
Squaw Creek	109	22	Down
W. Bailey Creek	83	42	Down
Upper W. Bailey Creek	67	9	Down
Willow Creek	150	11	Down
TOTAL	1964	418	Down 79%
MEAN	89.27	19.00	

Table 6. Prediction of Defoliation for 1977 and 1978, Bridger-Teton National Forest.

AREA	Predicted Defoliation 1977		Predicted Defoliation 1978		
	Egg Masses/plot	DAMAGE	Egg Masses/plot	DAMAGE	TREND
Astoria Hot Springs	28	Very Heavy	2	Light	Down
Bull Hollow	25	Very Heavy	4	Moderate	Down
Deer Creek	27	Very Heavy	21	Heavy	Down
Fall Creek	29	Very Heavy	23	Heavy	Down
Game Creek	62	Very Heavy	29	Very Heavy	Down
Higby Creek	30	Very Heavy	18	Heavy	Down
Horse Creek	61	Very Heavy	14	Heavy	Down
Lower Cache Creek	38	Very Heavy	34	Very Heavy	Down
Lower Leeks Canyon	23	Heavy	24	Heavy	Up
Mill Creek	10	Heavy	32	Very Heavy	Up
Miller	49	Very Heavy	2	Light	Down
N. F. Murphy Creek	10	Heavy	21	Heavy	Up
Palmer Creek	11	Heavy	2	Light	Down
Porcupine Creek	58	Very Heavy	78	Very Heavy	Up
Radio Point	58	Very Heavy	56	Very Heavy	Down
Rogers' Gulch	28	Very Heavy	23	Heavy	Down
Roos Creek	59	Very Heavy	11	Heavy	Down
Snow King	78	Very Heavy	57	Very Heavy	Down
Squaw Creek	23	Heavy	28	Very Heavy	Up
Twin Creek Ranch	27	Very Heavy	28	Very Heavy	Up
Upper Cache Creek	30	Very Heavy	1	Light	Down
Upper Leeks Canyon	77	Very Heavy	58	Very Heavy	Down
Upper West Bailey	53	Heavy	23	Heavy	Down
West Bailey	43	Very Heavy	8	Heavy	Down
Willow Creek	38	Very Heavy	12	Heavy	Down
Wilson Canyon	83	Very Heavy	69	Very Heavy	Down
MEAN	40.7	Very Heavy	26.1	Very Heavy	Down